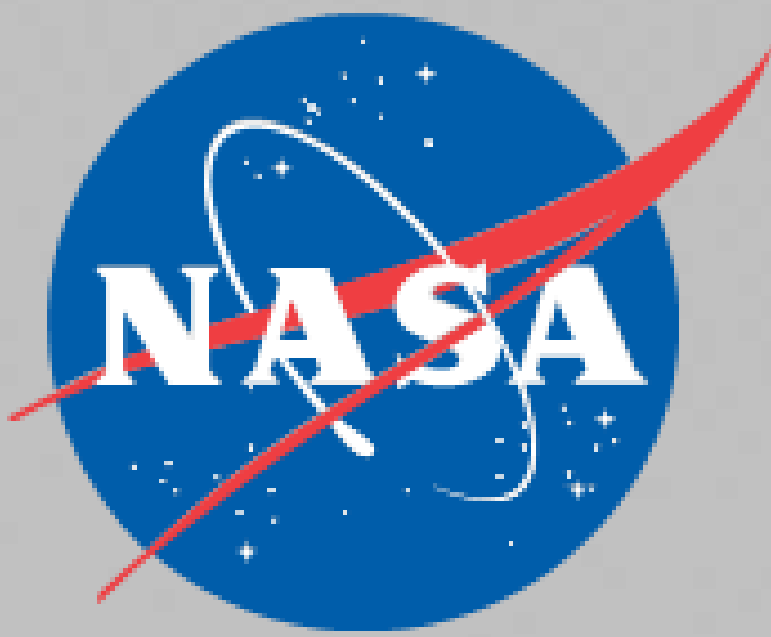




Microbial monitoring from the frontlines to space: Department of Defense Small Business Innovation Research technology aboard the International Space Station



Cherie M. Oubre¹, Christina L. Khodadad², Victoria A. Castro¹, C. Mark Ott³, Stephanie Flint³,
Lawrence P. Pollack⁴, Monserrate C. Roman⁵

¹KBRWyle, Houston, TX 77058, ²Sierra Lobo, Inc., Kennedy Space Center, FL, 32899; ³NASA Johnson Space Center, Houston, TX 77058;
⁴Defense Threat Reduction Agency, Fort Belvoir, VA 22060; ⁵NASA Marshall Space Flight Center, Huntsville, AL 35807

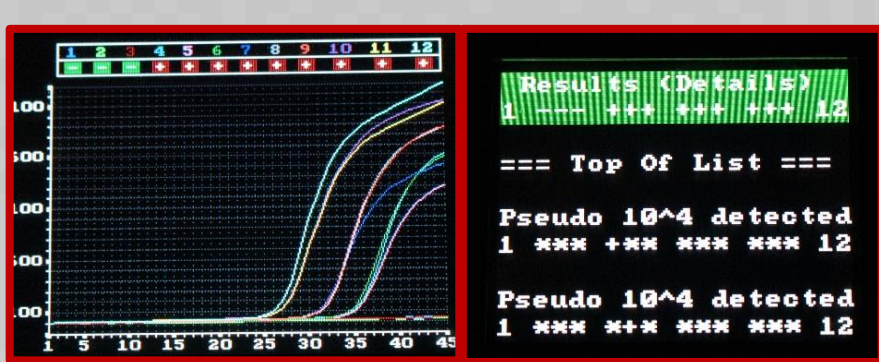
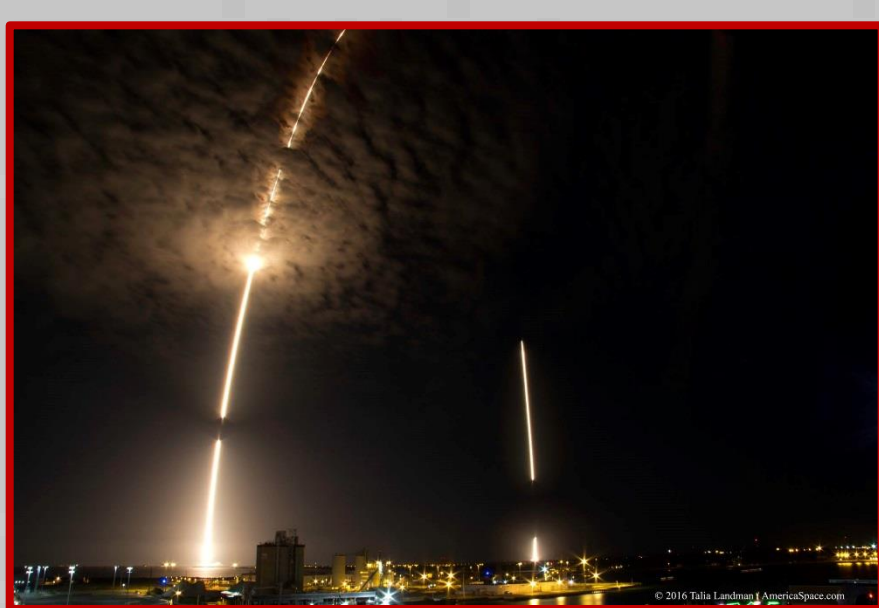
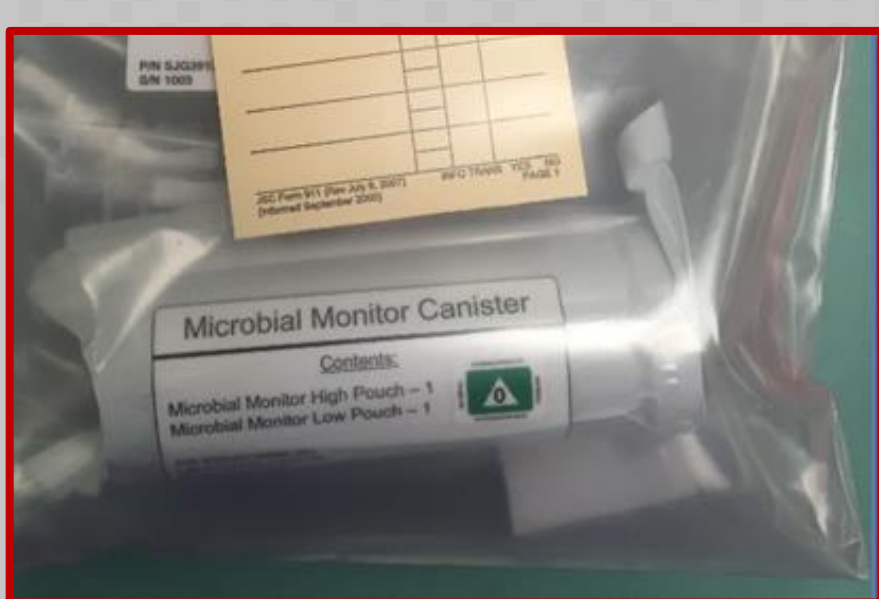


The RAZOR[®] EX, a quantitative Polymerase Chain Reaction (qPCR) instrument, is a portable, ruggedized unit that was designed for the Department of Defense (DoD) with its reagent chemistries traceable to a Small Business Innovation Research (SBIR) contract beginning in 2002. The PCR instrument's primary function post 9/11 was to enable frontline soldiers and first responders to detect biological threat agents and bioterrorism activities in remote locations to include field environments. With its success for DoD, the instrument has also been employed by other governmental agencies including Department of Homeland Security (DHS). The RAZOR[®] EX underwent stringent testing by the vendor, as well as through the DoD, and was certified in 2005. In addition, the RAZOR[®] EX passed DHS security sponsored Stakeholder Panel on Agent Detection Assays (SPADA) rigorous evaluation in 2011.

The identification and quantitation of microbial pathogens is necessary both on the ground as well as during spaceflight to maintain the health of astronauts and to prevent biofouling of equipment. Currently, culture-based monitoring technology has been adequate for short-term spaceflight missions but may not be robust enough to meet the requirements for long-duration missions. During a NASA-sponsored workshop in 2011, it was determined that the more traditional culture-based method should be replaced or supplemented with more robust technologies. NASA scientists began investigating innovative molecular technologies for future space exploration and as a result, PCR was recommended. Shortly after, NASA sponsored market research in 2012 to identify and review current, commercial, cutting edge PCR technologies for potential applicability to spaceflight operations. Scientists identified and extensively evaluated three candidate technologies with the potential to function in microgravity. After a thorough voice-of-the-customer trade study and extensive functional and safety evaluations, the RAZOR[®] EX PCR instrument (BioFire Defense, Salt Lake City, UT) was selected as the most promising current technology for spaceflight monitoring applications.

In 2015, the RAZOR[®] EX hardware was chosen as one of the commercial-off-the-shelf instruments incorporated into the Water Monitoring Suite of technologies for rapid development and flight demonstration. The RAZOR[®] EX launched on SpaceX-9 in July 2016 and flight testing initiated with validation and hardware functionality, and established consistency with ground controls.

A series of DoD-funded precursor SBIR projects and collaborations with military government agencies successfully led to the RAZOR[®] EX development and produced a beneficial product to address technology requirements of multiple customers. The on-board experiments have shown the existing instrumentation can be used in many environmental scenarios, both land-based as well as space-based. NASA's in-flight testing of the technology validated its functionality and sensitivity in microgravity. The instrument's small footprint, portability, and direct 'sample-to-answer' results provide autonomy to crewmembers. RAZOR[®] EX also provides a potential viable system to address microbial monitoring requirements necessary for future, long-duration spaceflight missions.



1999: Idaho
Technology
SBIR for
JBAIDS field
PCR

2004:
RAZOR[®] EX
system
developed

2011: RAZOR[®] EX
biosurveillance
system SPADA
validation by DHS

2012: NASA
Microbial
Monitor
Project

2014: RAZOR[®]
EX identified
as candidate
for spaceflight

July 2016:
RAZOR[®] EX
Launched
to ISS

July 2017:
Flight test
complete

2002: Idaho
Technology
SBIR for
freeze-dried
real-time PCR
reagents

2008: RAZOR[®]
EX system
upgraded with
color screen

2012: Idaho
Technologies
becomes
BioFire
Diagnostics,
Inc.

2014: BioFire
Defense
created from
bioMérieux
acquisition

Feb 2015:
Selected for
flight
hardware
demonstration

Sept 2016:
Began on-
orbit testing

